



NATIONAL UNIVERSITY OF ENGINEERING

COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL ENGINEERING

MINING ENGINEERING PROGRAM

MI636 – TUNNELS AND MATERIALS MOVEMENT

I. GENERAL INFORMATION

CODE	: MI636 Tunnels and Materials Movement
SEMESTER	: 6
CREDITS	: 3
HOURS PER WEEK	: 5 (Theory–Practice)
PREREQUISITES	: MI514 Introduction to Mining ME315 Electrical Engineering
CONDITION	: Compulsory
DEPARTMENT	: Mining Engineering

II. COURSE DESCRIPTION

The course prepares students for understanding and applying the concepts techniques and methods for the design, construction and operations of mining tunnels. Students analyze and integrate the processes for identifying the mean, design and construction making use of proper norms and standards. Students apply methods for construction of openings and underground works pointing to smooth and safe mining operations along the project life span.

III. COURSE OUTCOMES

At the end of the course, students:

1. Understand rock and soil dynamics and behavior when an opening is made taking into account rock properties and opening methods.
2. Explain the mechanical behavior of rock mass, as well as analyze the control of deformations.
3. Apply methods and techniques for predicting rock as soil deformations.
4. Understand the process of generation of arc effect and calibrate it according to drilling methods, and stress and stability conditions.
5. Organize tunnel construction activities using methods of drilling and blasting.
6. Determine and size the required equipment and resources for tunnel construction and maintenance.
7. Apply proper methods for assuring tunnel stability and safety along the mining operation time span.

IV. LEARNING UNITS

1. INTRODUCTION

History and technological evolution / Mining applications / Tunnel construction processes / Trends in tunnel construction technology / Megaprojects / Tunnel construction using modern technologies.

2. TUNNEL CONSTRUCTION PROCESS

Arc effect / The mean: rocks and soils / Behavior of the means subject to stress / Geomechanic behavior classification / Action and reaction / Mean perturbation / Influence radius / Deformation as mean response / Over break / Tunnel construction methods / Drilling and excavation methods.

3. MEAN DEFORMATION

Deformation behavior at the top, side and bottom of the tunnel / Extrusion / Pre-convergence / Convergence / Deformation behavior and opening size / Deformation analysis / Methods for controlling deformations / Pre-confinement / Confinement.

4. DEFORMATION PREDICTION AND CONTROL

Methods and procedures / Solid load method / Block theory / Plastic band method / Characteristic line method / Numeric analysis / Finite elements / tunnel instability by stability structures / Portico / Forward and backward control.

5. TUNNEL DESIGN

Possible events in rock mass / Recognition phase / Recognition for conventional excavation / Area hydrogeological and morphological characteristics / Terrain definition at tunnel axis / Geological and tectonic structures and stress state of rock mass / Hydrogeological regime of rock mass / Geomechanical characteristics / Excavation with TBM / Pilot tunnel / Geophysical methods / Operational decisions / Conventional mechanized excavations / Tunnel design using conventional excavation / Intervention for stabilization / Pre-confinement intervention / Shortcrete coating / Reinforcement with glass fiber structural elements / Truncated cone / Cell arc technology / Confinement intervention / Shortcrete for preliminary coating / Radial screwing / Inverted tunnel.

6. OPERATIONAL PHASE WITH CONVENTIONAL METHOD

Tunnels construction stages with drilling and blasting / Working cycle / Drilling / Driller classification / Drilling accessories / Blasting / Explosive and accessories / Fragmentation process / Drilling nets / Blasting sequence / Explosive types / Tunnel drilling and blasting / Chimney construction methods / Tunnel ventilation / Tunnel cleaning / Load transport equipment / Working cycle times / Steel arcs / Anchorage screws / Bars and cables / Mechanical anchorage / Dry and humid roads / Safety during construction / Environmental care.

V. PRACTICAL EXPERIENCES

1. Visit to a mining field with tunnel operations.
2. Visit to a mining field with tunnel operations.

VI. METHODOLOGY

This course is organized in sessions of theory, practice and field visits. In theory sessions the concepts and applications are explained. In practice sessions, real cases related to tunnel construction and operations. In field study sessions, students visit mining fields with tunnel construction and operation.

VII. GRADING FORMULA

The Final Grade PF is calculated as follow:

$$PF = (EP + EF + PP) / 3$$

EP: Mid-term Exam EF: Final Exam
PP: Average grade of practice work

VIII. BIBLIOGRAPHY

1. LUNARDI Pietro

Design and Construction of Tunnels
Springer-Verlag 2016

2. BIENIAWSKI Z.T.

Design in Mining and Tunneling, 2015.